ARJUNA

JEE

LECTURE - 11

Atomic structure

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01 Hund's rule

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Q. How many subshell present in 3rd shell

50Sec ⇒

A 1

B 2

C 3 ✓

D 4

$n = 3$ → shell

l → 0 to $(n-1)$

↓

subshell → 0, 1, 2

C_{SD} = total value of l = n = 3

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4. Spin Quantum number

→ spin Q. No., not a solution of Schrodingar wave Eq.
↓
(n, l, m)

1l

↓
orbital → max. $2e^-$ filled hote hai

↑ → clockwise → s or $m_s = +\frac{1}{2}$

↓ → Anticlockwise → s or $m_s = -\frac{1}{2}$

Q

↑		

Select the correct value of spin Quantum number (s) for above e^-

(a) $s = -\frac{1}{2}$ ✗

(b) $s = \pm\frac{1}{2}$ ✗

✓ (c) $s = +\frac{1}{2}$

(d) $s = +1$ ✗

$s = +\frac{1}{2} \rightarrow \uparrow$

$s = -\frac{1}{2} \rightarrow \downarrow$

$C_{5D} = 25$

n = No. of shell

l = subshell

m_l or m = orbital

m_s or s = $+\frac{1}{2}$ or $-\frac{1}{2}$

(3) → total No. of e^- in any subshell

$= 2(2l+1)$

→ total No. of e^- in any shell $= 2n^2$

1. { total No. of value of 'l' for n^{th} shell ⇒ value of n
   Kon Kon se subshell honge → 0 to $n-1$

2. { total No. of value of 'm' for 'l' subshell = $(2l+1)$
   Kon Kon se orbital honge = $-l$ to $+l$
   total No. of orbital in n^{th} shell $= n^2$

Q. How many orbitals in d-subshell

(a) 2

(b) 3

(c) 7

✓ (d) 5

No. of orbital $= 2l+1$

$= 2 \times 2 + 1$

$= 5$

Q → Calculate total number of orbital in d-subshell ($l=2$)

(a) 1

(b) 3

(c) 5 ✓✓

(d) 7

(M-1) No. of orbital in subshell

$= 2l+1 = 2\times2+1 = 5$

(M-2) $l = 2$

$m = -2, -1, 0, +1, +2$

Q - Calculate total No. of orbital in 2^{nd} shell ($n=2$)

(a) 1

(b) 4

(c) 3

(d) 7

(M-1) total No. of orbital in n^{th} shell $= n^2$

$= (2)^2 = 4$

(M-2) $n = 2$

subshell (l) → 0 to ($n-1$)

$l = 0, 1$

$l=0 \rightarrow m = 0$ —

$l = 1 \rightarrow m \Rightarrow$ −1 —, 0 —, +1 —

Q50. For azimuthal quantum number $l = 3$, the maximum number of electrons

(a) 2

(b) 6

(c) 0

(d) 14 ✓

(M-1) No. of electron in subshell $= 2(2l+1)$

$= 2(2\times3+1)$

$= 14$

or

(M-2) → $l = 3$

$m = -l$ to $+l$

-3, -2, -1, 0, $+1$, $+2$, $+3$

7-orbital

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Q3. How many electrons can fit in the orbital for which n = 3 and l = 1?

(X)

30 sec

(a) 2

(b) 6 ✓✓

(c) 10

(d) 14

(M-1) total $e^- = 2(2l+1) = 2(2\times1+1) = \underline{6}$

(M-2) $l = 1 \rightarrow m = \begin{cases} -1 \\ 0 \\ +1 \end{cases}$

↓

p-subshell

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Q11. Maximum number of electrons in a subshell with I = 3 and n = 4 is

(a) 14

(b) 16

(c) 10

(d) 12

20 Sec

$= 2(2l+1)$

$= 2(2\times3+1)$

$= 14$

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Q → $n = 3$, $l = 2$. How many e^- and orbital present in above Quantum number

(a) 10, 5

✓ (b) 5, 10

(c) 9, 18

(d) 18, 9

meaning ⇒ total Kitne orbital and e^- 2nd subshell (d) me ho sakte hai

→ ?

→ orbital $= 2l+1 = 2\times2+1 = 5$

total $e^- = 2(2l+1) = 5\times2 = 10$

3rd shell ($n=3$)

$l = 0, 1, 2$

Q-1 → Calculate value of all quantum number for $n=2$ (second shell)

Sol^n ⇒ Meaning = 2^{nd} shell me sabhi subshell aur sabhi orbital and total e^- ke liye Quantum number Ki value batani hai

Shell	subshell (l) 0 to $n-1$	orbital (m) $-l$ to $+l$	s	
$n=2$ →	0 → s-subshell →	0	$\pm\frac{1}{2}$	↑↓
	1 – p-subshell →	-1	$\pm\frac{1}{2}$	
		0	$\pm\frac{1}{2}$	
		$+1$	$\pm\frac{1}{2}$	

Aufbau principle

- It states that electrons are filled into atomic orbitals in the increasing order of orbital energy level. According to the Aufbau principle, the available atomic orbitals with the lowest energy levels are occupied before those with higher energy levels.

subshell

subshell

→ Arrangement of e^- in subshell

→ e^- filled in increasing order of energy of subshell, It means lowest energylevel subshell filled 1st.

$(n+l)$-Rule ⇒ Arrange energy of subshell

> ① Energy of subshell $\propto (n+l)$

Ex → 1s, 2s, 2p ⇒ $1s < 2s < 2p$

	1s	2s	2p
$n=$	1	2	2
$l=$	0	0	1
$n+l$	1	2	3

l	subshell
0 →	s-subshell
1 →	p - " "
2 →	d → " "
3 →	f → " "
4 →	g → " "
5 →	h → " "

(2) If $(n+l)$ = same for no. of subshell

$\Rightarrow$ Energy of subshell $\propto n$

Q Arrange increasing order of energy of given subshell

2p, 3s, 3d, 4s, 3d, 4d, 5p, 5s

Sol^n

	2p	3s	3d	4s	3d	4d	5p	5s
$n =$	2	3	3	4	3	4	5	5
$l =$	1	0	2	0	2	2	1	0
$n+l$	3	3	5	4	5	6	6	5

$2p < 3s < 4s < 3d < 5s < 4d < 5p$

Q Select correct order of energy of subshell

(a) ✓ $3s < 3p$ (3+0, 3+1)

(b) ✗ $3p > 3d$ (3+1, 3+2)

(c) ✓ $5s < 4d$ (5+0, 4+2)

(d) ✗ $6p < 4f$

$6+1 = 4+3$

6   4

Q → select correct order of energy

(a) $5s < 4p$ → ✗
($5+0$, $4+1$)

(b) $3d < 4f$ ✓
($n = 3+2$, $4+3$)

(c) $1s > 2s$ — ✗
($1+0$, $2+0$)

(d) $6s > 5f$ — ✗
($6+0$, $5+3$)

Order of Energy

1 → 1s

2 → 2s 2p

3 → 3s 3p 3d

4 → 4s 4p 4d 4f

5 → 5s 5p 5d 5f

$N = 7 \rightarrow 1s^2, 2s^2, 2p^3$

subshell	orbital	e^-
$(l=0)$ s →	1 →	2
$l=1$ p →	3 →	6
$l=2$ d →	5 →	10
$l=3$ f →	7 →	14

$Na = 11 \rightarrow 1s^2, 2s^2, 2p^6, 3s^1$

$Cl = 17 \rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^5$

Energy order $\Rightarrow$ $\underline{1s} < \underline{2s} < \underline{2p} < \underline{3s} < \underline{3p} < 4s < 3d < 4p < 5s < 4d < 5p < 6s$
$< 4f < 5d < 6p < 7s < 5f < 6d < 7p < 8s$

$\underline{Sn = 50} \rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^{10}, 4s^2, 4p^6, 5s^2, 4d^{10}, 5p^2$

Q How many $\bar{e}$ filled in p-subshell of Zn (30)

(a) 6

✓(b) 12

(c) 18

(d) None of these

$Zn = 30 = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}$

$6 + 6 = 12e^-$

Q How many $\bar{e}$ filled in s-subshell of ($Cl = 17$) atom

(a) 4

(b) 6 ✓

(c) 8

(d) 10

$Cl = 17 \Rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^5$

$2 + 2 + 2 = 6$

Note ⇒ $s^2, d^4 \longrightarrow s^1, d^5$

$s^2, d^9 \longrightarrow s^1 d^{10}$

→ stability increases

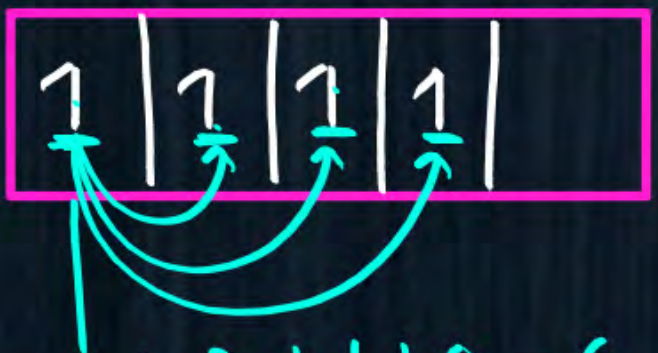
Reason ⇒ due to high exchange energy

or

due to extra stability of half filled and full filled d-subshell

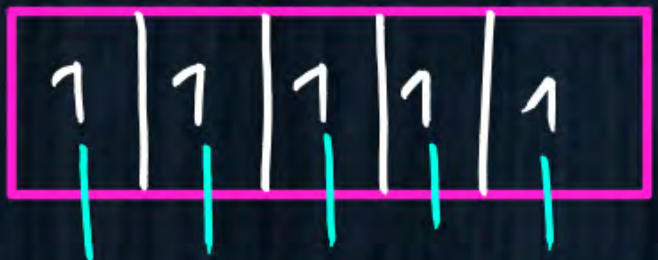
Ex ⇒

d^4



exchange energy $= 3 + 2 + 1 + 0 = 6$

d^5



$4 + 3 + 2 + 1 + 0 = 10$

$Cr = 24 \rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^4 \rightarrow$ wrong

$\rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1, 3d^5 \rightarrow$ (R)

$Cu = 29 \rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^9 \rightarrow$ wrong

$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1, 3d^{10} \rightarrow$ (R)

Thank - You